GEOTEST ENGINEERING, INC.

Geotechnical Engineers & Materials Testing

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Job Nos. 1140193701
1140193801
Supplemental Report No.1
September 12, 2014

Mr. Will Wilshire, P.E.
Lockwood Andrews & Newnam, Inc.
2925 Briarpark Drive, Suite 400
Houston, Texas 77042

Re: **Supplemental Geotechnical Recommendations**
Surface Water Transmission Program
84-inch Interconnection at EWPP
WBS No. S-000902-0132-3
LLPS Direct Connection and PRS at EWPP
WBS No. S-000902-0133-4
Houston, Texas

Dear Mr. Wilshire:

Submitted herein is a supplemental report to Geotest Engineering, Inc. (GEI) Report No. 1140193701, dated December 3, 2013 and Report No. 1140193801, dated May 14, 2014. This report presents the supplemental recommendations for tunneling construction in the area of crossing of Hunting Bayou. Based on the subsurface conditions revealed by borings GLLP-1 and GLLP-2 (drilled for WBS No. S-000902-0133-4, GEI Job No. 1140193801) and GWL-3P and GWL-4 (drilled for WBS No. S-000902-0132-4, GEI Job No. 1140193701), water bearing sandy silt, clayey silt and silt were encountered at the depths of the proposed invert of the 84-inch water line under the Hunting Bayou. The approximate locations of these borings are shown on Figure 1. The logs of these borings are also presented on Figures A-1 through A-4. A boring log profile was developed to include these four borings and is shown on Figure 2. It should be noted that no borings were drilled within the channel of the bayou and anomalous ground conditions may exist under the Hunting Bayou.

Access Shaft for Tunneling

As recommended in GEI Report No. 1140193801, the groundwater at the location of access shaft areas may be controlled by installation of sheet pile cut off wall with local dewatering system

such as eductor well to lower or relieve the hydrostatic pressures. Any minor seeping water can then be controlled by leading to a sump and pump.

Tunneling Under Hunting Bayou

The proposed 84-inch water line placed at approximate El. -34 feet will be constructed by tunneling method. Based on the knowledge of the soil conditions (as revealed by the borings) encountered near the Hunting Bayou, the tunneling operation will require the use of proper tunneling equipment that can fully breast the excavation face. In addition, the tunneling contractor should have sufficient knowledge and significant experience to work under the bayou with soil conditions that consist of water bearing sandy silt, silt and clayey silt, where dewatering of the canal excavation cannot be achieved under the bayou. Thus, it is recommended that the proposed 84-inch water line be constructed using at a minimum, a closed faced TBM. Closed face TBM will provide positive support of the ground and minimize the potential for problematic groundwater inflows into the tunnel excavation.

If you have any questions regarding these recommendations, please do not hesitate to call us at (713) 266-0588.

Very truly yours,
GEOTEST ENGINEERING, INC.

K. Naresh

Naresh Kolli, P.E.
Assistant Project Manager

B. C. M

Mohan Ballagere, P.E.
Vice President

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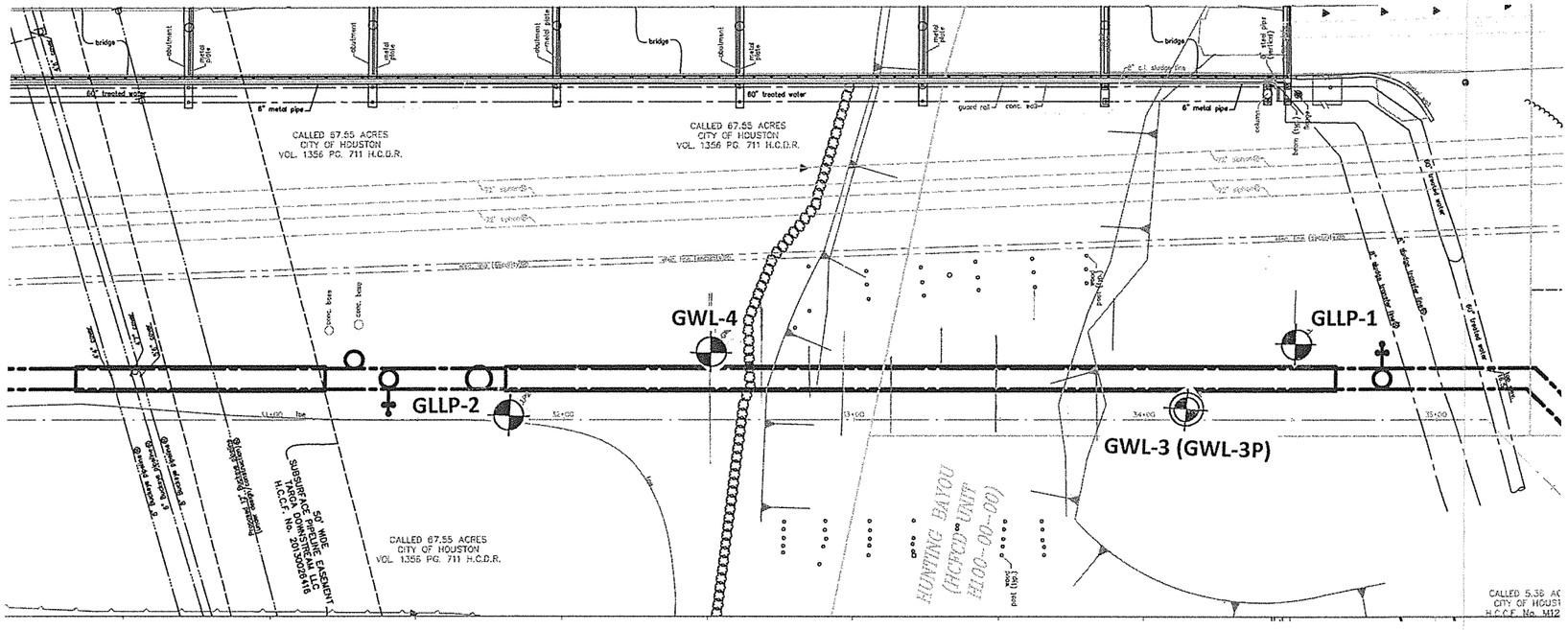
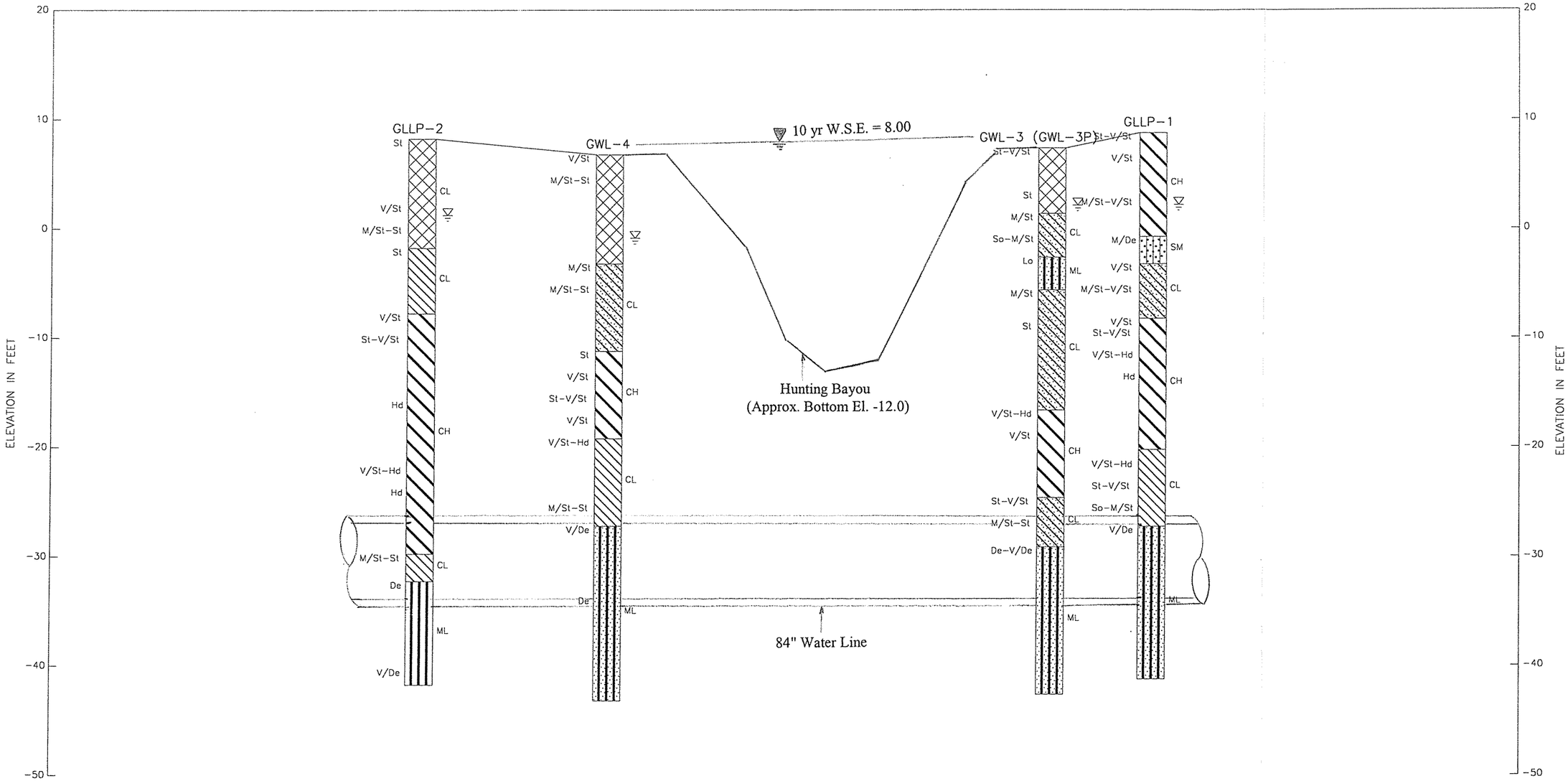
Attachments: Figure 1 – Plan of Borings
Figure 2 – Boring Log Profile
Figure 3 – Symbols and Abbreviations Used on Boring Log Profile
Figures A-1 thru A-4 – Log of Borings
Copies: (1-pdf)
PC38/Geotechnical/40193701_and40193801_Supplemental Rep1_Final

Job No. 1140193701 and 1140193801



Legend	Geotest Engineering, Inc
Boring	SURFACE WATER TRANSMISSION PROGRAM 84-INCH INTERCONNECTION AT EWPP WBS NO. S-000902-0132-3 LLPS DIRECT CONNECTION AND PRS AT EWPP WBS NO. S-000902-0133-4 HOUSTON, TEXAS
Boring w/Piezometer	**PLAN OF BORINGS** 0 25 50 SCALE IN FEET

FIGURE 1



GENERAL NOTES:

1. See Figure 1 for approximate location of borings.
2. Data concerning subsurface conditions have been obtained at boring locations only. Actual conditions between borings may differ from the profile shown here.
3. See logs of boring for detailed description of soils encountered in each borehole.
4. See Figure 3 for symbols and abbreviations used on this profile.
5. Ground surface elevation at each boring location was based on survey data provided to us by LAN, Inc.

BORING LOG PROFILE

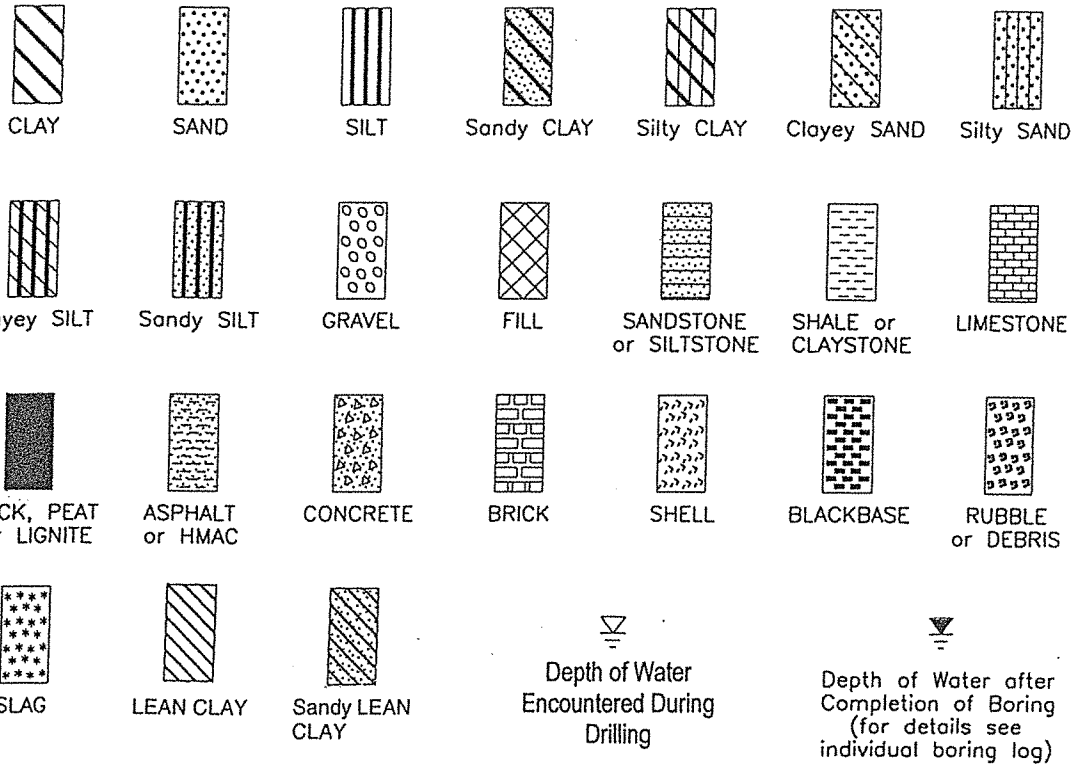
84-Inch Water Line at Hunting Bayou

0 20 40 60 80

HORIZONTAL SCALE IN FEET

SYMBOLS AND ABBREVIATIONS USED ON BORING LOG PROFILE

LEGEND



ABBREVIATIONS USED FOR CONSISTENCY/DENSITY

COHESIVE SOILS

V/So	: Very Soft
So	: Soft
Fm	: Firm
M/St	: Medium Stiff
St	: Stiff
V/St	: Very Stiff
Hd	: Hard
V/Hd	: Very Hard

COHESIONLESS SOILS

V/Lo	: Very Loose
Lo	: Loose
S/Co	: Slightly Compact
Co	: Compact
M/De	: Medium Dense
De	: Dense
V/De	: Very Dense

LOG OF BORING NO. GLLP-2

PROJECT : SWTP – Low Lift Pump Station (LLPS) Direct Connection and Pressure Regulating Station (PRS) at EWPP
WBS No. S-000900-0133-3; Houston, Texas

PROJECT NO. : 1140193801

LOCATION : N 13837866.47, E 3169200.07
See Plan of Borings (Figure 2)

COMPLETION DEPTH : 50.0 FT.

SURFACE ELEVATION : 8.23 FT.

DATE : 11-04-13

SAMPLER : Shelby Tube/Split Spoon
DRY AUGER : 0.0 TO 14.0 FT.
WET ROTARY : 14.0 TO 50.0 FT.

ELEVATION, FEET	DEPTH, FEET	DESCRIPTION OF MATERIAL	STANDARD PENETRATION TEST, BLOWS PER FOOT	PERCENT PASSING NO. 200 SIEVE	DRY UNIT WEIGHT, PCF	NATURAL MOISTURE CONTENT, %	LIQUID LIMIT, %	PLASTIC LIMIT, %	PLASTICITY INDEX, %
8.2	0	FILL: stiff yellowish brown and gray LEAN CLAY (CL) w/sand				17			
		-w/grass roots 0'-2'		77		21	46	17	29
	5	-w/calcareous nodules 0'-10'				16			
		-very stiff 6'-8'				15			
		-medium stiff to stiff yellowish brown and dark gray fat clay w/sand partitions 8'-10'		78	104	22	53	20	33
-1.8	10	Stiff gray LEAN CLAY w/sand (CL)				18			
		-gray and brown w/ferrous nodules and ferrous stains 14'-16'				20			
-7.8	15	Very stiff gray and yellow FAT CLAY (CH) w/sand seams				17			
		-stiff to very stiff 18'-20'				19			
	20	-w/calcareous nodules 20'-36'		89	107	20	57	23	34
		-hard 24'-30'				21			
	25	-gray and red 26'-28'				21			
						16			
						18			
	30	-very stiff to hard, slickensided 30'-32'				19			
		-w/ferrous nodules 30'-34'		95	108	22	63	24	39
		-w/clay stone seams 30'-38'				22			
	35	-hard 32'-38'				20			
-29.8						21			
	40	Medium stiff to stiff reddish brown LEAN CLAY (CL)		95	104	23	35	19	16
-32.3		Dense reddish brown SILT (ML)	48			24			
		-w/clayey seams 43.5'-45'	41	93		21			
	45								
		-very dense 48.5'-50'	50			26			
-41.8	50								

UNDRAINED SHEAR STRENGTH, TSF
○ HAND PENETROMETER
● UNCONFINED COMPRESSION
■ UNCONSOLIDATED-UNDRAINED TRIAXIAL COMPRESSION
△ TORVANE
0.5 1.0 1.5 2.0 2.5

DEPTH TO WATER IN BORING :
▽: FREE WATER 1st ENCOUNTERED AT 14.0 FT. DURING DRILLING; AFTER 20.0 MIN. AT 7.0 FT.
HOLE OPEN TO 50.0 FT. AT END OF DRILLING.

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FIGURE A-1

LOG OF BORING NO. GWL-4

PROJECT : Surface Water Transmission Program; 84-inch Interconnect at East Water Purification Plant (EWPP) WBS No. S-000900-0132-3; Houston, Texas

PROJECT NO. : 1140193701

LOCATION : N 13837935.00, E 3169175.14 See Plan of Borings (Figure 2)

COMPLETION DEPTH : 50.0 FT.

SURFACE ELEVATION : 6.79 FT.

DATE : 04-15-13

SAMPLER : Shelby Tube/Split Spoon

DRY AUGER : 0.0 TO 12.0 FT.

WET ROTARY : 12.0 TO 50.0 FT.

ELEVATION, FEET	DEPTH, FEET	DESCRIPTION OF MATERIAL	STANDARD PENETRATION TEST, BLOWS PER FOOT	PERCENT PASSING NO. 200 SIEVE	DRY UNIT WEIGHT, PCF	NATURAL MOISTURE CONTENT, %	LIQUID LIMIT, %	PLASTIC LIMIT, %	PLASTICITY INDEX, %
6.8	0	FILL: very stiff brown sandy lean clay -w/grass roots 0'-2' -medium stiff to stiff 2'-4'				14			
						20			
	5	-medium stiff to stiff yellowish brown, gray fat clay w/calcareous and ferrous nodules 2'-10'		86	107	22	51	21	30
		-w/ferrous stains 4'-8'				21			
-3.2	10	-gray and reddish brown 6'-8' -gray 8'-10'				30			
						18			
		Medium stiff gray SANDY LEAN CLAY (CL) w/sand seams		69	105	20	28	15	13
	15	-medium stiff to stiff 12'-14'				23			
-11.2		-w/ferrous nodules 14'-16' -w/clay seams 14'-18'				23			
	20	-yellowish brown and gray 16'-18'				24			
						21			
		Stiff yellowish brown and gray FAT CLAY (CH) w/calcareous and ferrous nodules, sand seams and ferrous stains		88	107	21	63	24	39
	25	-very stiff 20'-22'				23			
-19.2		-stiff to very stiff, slickensided 22'-24'				21			
	30	-very stiff 24'-26'		97	116	17	43	19	24
						20			
		Very stiff to hard gray and reddish brown LEAN CLAY (CL) w/sand seams		88		22	30	18	12
-27.2	35	-w/calcareous nodules 30'-32'	68	69		22			
		-medium stiff to stiff 32'-34'	75			25			
		Very dense gray and reddish brown SANDY SILT (ML)	51 / 7.0"	73		26			
	40	-reddish brown silt w/sand 38'-40'	43			24			
		-dense 40.5'-42'							
	45	-w/gravel and clay seams 43.5'-50'	77	69		25			
-43.2	50		91 / 5.5"			21			

UNDRAINED SHEAR STRENGTH, TSF

- ○ HAND PENETROMETER
- ● UNCONFINED COMPRESSION
- ■ UNCONSOLIDATED-UNDRAINED TRIAXIAL COMPRESSION
- △ TORVANE

0.5 1.0 1.5 2.0 2.5

DEPTH TO WATER IN BORING :

▽: FREE WATER 1st ENCOUNTERED AT 11.0 FT. DURING DRILLING; AFTER 20.0 MIN. AT 7.7 FT. HOLE OPEN TO 50.0 FT. AT END OF DRILLING.

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FIGURE A-2

LOG OF BORING NO. GWL-3 (GWL-3P)

PROJECT : Surface Water Transmission Program; 84-inch Interconnect at East Water Purification Plant (EWPP) WBS No. S-000900-0132-3; Houston, Texas

PROJECT NO. : 1140193701

LOCATION : N 13838098.33, E 3169183.95 See Plan of Borings (Figure 2)

COMPLETION DEPTH : 50.0 FT.

SURFACE ELEVATION : 7.38 FT.

DATE : 04-16-13

SAMPLER : Shelby Tube/Split Spoon

DRY AUGER : 0.0 TO 12.0 FT.

WET ROTARY : 12.0 TO 50.0 FT.

UNDRAINED SHEAR STRENGTH, TSF
○ HAND PENETROMETER
● UNCONFINED COMPRESSION
■ UNCONSOLIDATED-UNDRAINED TRIAXIAL COMPRESSION
△ TORVANE
0.5 1.0 1.5 2.0 2.5

ELEVATION, FEET	DEPTH, FEET	DESCRIPTION OF MATERIAL	STANDARD PENETRATION TEST, BLOWS PER FOOT	PERCENT PASSING NO. 200 SIEVE	DRY UNIT WEIGHT, PCF	NATURAL MOISTURE CONTENT, %	LIQUID LIMIT, %	PLASTIC LIMIT, %	PLASTICITY INDEX, %
7.4	0	FILL: stiff to very stiff brown sandy lean clay w/grass roots, gravel and calcareous and ferrous nodules				20			
		-stiff 4'-6'			102	22			
	5			65		18	44	20	24
1.4		Medium stiff gray and yellowish brown SANDY LEAN CLAY (CL) w/ferrous nodules				29			
		-soft to medium stiff 8'-10'				42			
-2.6	10		5	58		19			
-5.6		Loose gray SANDY SILT (ML)				30			
	15	Medium stiff yellowish brown and gray SANDY LEAN CLAY (CL) w/ferrous stains and sand seams		54	109	19	25	16	9
		-stiff 16'-18'				17			
		-w/ferrous nodules 18'-20'				21			
	20	-brown and red very sandy clay 20'-22'				22			
			9	56		22	44	20	24
-16.6	25	Very stiff to hard reddish brown and gray FAT CLAY (CH) w/calcareous nodules		88	107	21	54	22	32
		-slickensided 24'-26'				24			
		-very stiff 26'-28'							
	30	-w/gravel 28.5'-32'	33			21			
-24.6				95	106	21	50	21	29
	35	Stiff to very stiff reddish brown and gray SANDY LEAN CLAY (CL) w/sand seams				20			
		-medium stiff to stiff 34'-36'				21			
-29.1			61			21			
	40	Dense to very dense gray and reddish brown SANDY SILT (ML)	49	70		25			
		-w/calcareous nodules 36.5'-42'	65			22			
		-w/clay seams 40.5'-42'							
	45		76/3.0"			23			
-42.6	50		100/5.0"			18			

DEPTH TO WATER IN BORING :
▽: FREE WATER 1st ENCOUNTERED AT 10.0 FT. DURING DRILLING; AFTER 20.0 MIN. AT 5.3 FT.
HOLE OPEN TO 50.0 FT. AT END OF DRILLING.

Geotest Engineering, Inc.

FIGURE A-3

LOG OF BORING NO. GLLP-1

PROJECT : SWTP – Low Lift Pump Station (LLPS) Direct Connection and Pressure Regulating Station (PRS) at EWPP
WBS No. S-000900-0133-3; Houston, Texas

PROJECT NO. : 1140193801

LOCATION : N 13838135.06, E 3169162.79
See Plan of Borings (Figure 2)

COMPLETION DEPTH : 50.0 FT.

SURFACE ELEVATION : 8.78 FT.

DATE : 01-15-14

SAMPLER : Shelby Tube/Split Spoon
DRY AUGER : 0.0 TO 10.0 FT.
WET ROTARY : 10.0 TO 50.0 FT.

ELEVATION, FEET	DEPTH, FEET	DESCRIPTION OF MATERIAL	STANDARD PENETRATION TEST, BLOWS PER FOOT	PERCENT PASSING NO. 200 SIEVE	DRY UNIT WEIGHT, PCF	NATURAL MOISTURE CONTENT, %	LIQUID LIMIT, %	PLASTIC LIMIT, %	PLASTICITY INDEX, %
8.8	0	Stiff to very stiff gray and red FAT CLAY (CH) w/sand seams and calcareous nodules -very stiff 2'-6' -w/vertical sand seams 4'-6' -medium stiff to very stiff gray and red 6'-8'		96		21 24	68	26	42
	5			90	96	21 25	61	24	37
-0.7	10	Medium dense gray SILTY SAND (SM)	14	35		21			
-3.2		Very stiff brown and gray SANDY LEAN CLAY (CL) w/ferrous nodules and sand seams -medium stiff to very stiff 14'-16'		54	115	16 15	36	14	22
-8.2	15	Very stiff brown and gray FAT CLAY (CH) w/ferrous nodules and sand seams -stiff to very stiff 18'-20' -very stiff to hard 20'-22' -hard 22'-26' -reddish brown and gray 24'-26'				20 20			
	20			89	114	18 18	54	22	32
	25					18			
-20.2		-gray and red w/ferrous nodules and clay stone 28'-29'		93	109	18	51	21	30
	30	Gray and brown LEAN CLAY (CL) w/sand seams -very stiff to hard 30'-32' -stiff to very stiff 32'-34' -soft to medium stiff w/silt stone and calcareous nodules 34'-36'			111	18			
	35			96		22	37	19	18
-27.2			90			29 22			
	40	Very dense reddish brown SANDY SILT (ML) -w/gravel 40.5'-42'	56 100/6.0"	54		27 22			
	45		83			23			
-41.2	50		100/1.0"			23			

UNDRAINED SHEAR STRENGTH, TSF
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■ UNCONSOLIDATED-UNDRAINED TRIAXIAL COMPRESSION
△ TORVANE
0.5 1.0 1.5 2.0 2.5

DEPTH TO WATER IN BORING :
▽: FREE WATER 1st ENCOUNTERED AT 10.0 FT. DURING DRILLING; AFTER 20.0 MIN. AT 6.6 FT.
HOLE OPEN TO 50.0 FT. AT END OF DRILLING.

Geotest Engineering, Inc.

FIGURE A-4